B.C. IRRIGATION MANAGEMENT GUIDE

Chapter 5

Editor

Ted W. van der Gulik, P.Eng.

Authors

Stephanie Tam, B.A.Sc.
T. Janine Nyvall, P.Eng.
Lance Brown, Eng Tech

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LIMITATION OF LIABILITY AND USER'S RESPONSIBILITY

The primary purpose of this B.C. Irrigation Management Guide is to provide irrigation professionals and consultants with a methodology to assess the irrigation system performance and manage the system effectively.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to complete more advanced assessments. Advice of appropriate professionals and experts may assist in completing assessments that are not covered in this Guide.

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5 PLANTS, SOIL AND SOIL WATER

Soil and crop characteristics determine how an irrigation system should be designed and operated. The crop's rooting depth and water requirements are very important to the design and management of irrigation systems. A crop with a deeper rooting depth has a greater volume of soil water to draw from between irrigation than a shallow rooted crop. Crops also require different amounts of water at different times of the year. When the crop is at its development stage, it requires less water than a mature crop. Water requirement also depends on the type of crop. Some crops transpire and use more water than other crops at the same development stage.

The type of soil determines the application rate and irrigation interval of an irrigation system. Therefore, the soil type should be considered when designing an irrigation system.

A farm may be composed of a number of different crops, or the same crop at different growth stages and/or sizes. Soil type and topography may vary throughout a single field and to further complicate matters, the field may be using a number of different types of irrigation systems. Ideally, each crop and/or major soil type should have a separate irrigation system designed specifically for those conditions. However, this is not always the case, and the Irrigation Management Plan must be modified to fit each situation that is specific to the field.

Assessment 5.4, Soil-Crop Report, uses information from all the sections within this chapter to generate a summary of information about the farm that will be used in subsequent chapters. The information developed in this chapter is used to perform an irrigation assessment in Chapter 6.

5.1 Plants

Rooting Depth

The crop's rooting depth determines the depth of the soil profile from which the crop can extract soil water. Water that moves beyond this depth is unavailable to the crop. For areas where the water table is shallow, water moves up into the root zone through capillary action. For design and management decisions, only the water within the root zone is considered in the calculations. About 70% of the water uptake is within the top 50% of the root zone.

To determine the rooting depth, a test pit should be dug within the crop's root zone. The roots should be visible on the side of the test pit. The distance from the soil surface to the bottom of the root zone is the rooting depth.

The effective rooting depths of common crops are found in Table 5.1. Use these values only when it is not possible to obtain rooting depths from the field.

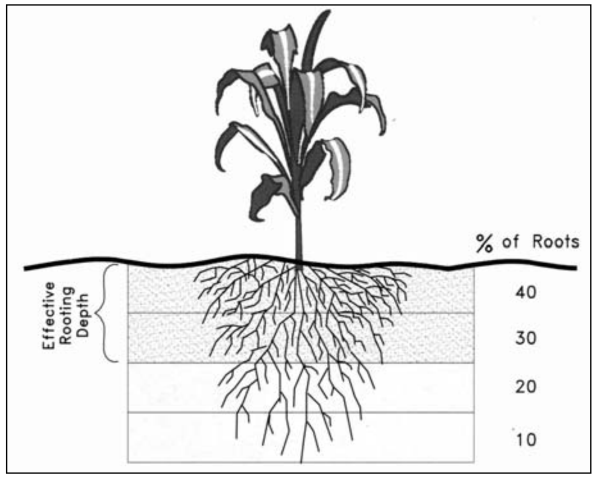


Figure 5.1 Rooting Depth

Table 5.1 Effective Rooting Depth of Mature Crops

Shallow 0.45 m (1.5 ft)	Medium Shallow 0.6 m (2 ft)	Medium Deep 0.9 m (3 ft)	Deep 1.2 m (4 ft)
Cabbages	Beans	Brussels Sprouts	Alfalfa
Cauliflowers	Beets	Cereal	Asparagus
Cucumbers	Blueberries	Clover (red)	Blackberries
Lettuce	Broccoli	Corn (sweet)	Corn (field)
Onions	Carrots	Eggplant	Grapes
Radishes	Celery	Kiwifruit	Loganberries
Turnips	Peas	Peppers	Raspberries
	Potatoes	Squash	Sugar beets
	Spinach	Saskatoons	Tree Fruits (12′ x 18′)
	Strawberries	Tree Fruits (6′ x 12′)	
	Tomatoes		
	Tree Fruits (3′ x 10′)		

Amount of Water Available to the Crop

As discussed above, the amount of soil water available to the crop depends on the type of soil and crop, the presence of boundary layers in the soil, and the effective rooting depth of the crop.

The total available water should not be depleted before irrigation water is applied. To prevent the crop from being stressed at low soil moisture levels, an availability coefficient (AC) is used to ensure the soil moisture stays in an acceptable range. The total amount of water stored in the soil is multiplied by the AC to obtain the maximum soil water deficit (MSWD), i.e., the amount of water that is readily available to the crops.

➔ **Maximum Soil Water Deficit, Section 5.3**

The MSWD depends on the crop type. Crops, such as peas and potatoes, cannot extract water from the soil very readily; therefore, requiring a higher soil moisture level to keep themselves from being stressed. Table 5.2 provides availability coefficients for various crops.

Table 5.2 Availability Coefficients

Crop	Maximum Percent [% expressed as decimal]
Peas	0.35
Potatoes	0.35
Tree Fruits	0.40
Grapes	0.40
Tomatoes	0.40
Others	0.50

Crop Development

Crop development determines how much water crops require. Annual crops planted from seed have a very shallow root zone upon crop emergence. The roots generally expand and progress deeper as the crop develops above ground. Over the irrigation season, the soil volume for water storage is initially small, but increases over time. The amount of irrigation water that can be applied therefore varies over the season. Perennial crops show a similar root zone expansion although it takes place over several years, as with the case of tree fruits and vine crops.

Crop canopy is the vegetative cover of the crop, and is directly related to the crop development. Evapotranspiration rate increases with increasing crop canopy.

➔ **Crops and the Climate, Chapter 7**

5.2 Soil

Understanding Soil's Role in Irrigation

Good irrigation practices combine proper irrigation system design, system operation and maintenance, as well as irrigation scheduling. Soil characteristics determine how an irrigation system should be designed and operated:

- Coarse and sandy soils generally have low water holding capacity and high infiltration rates.
  - Water is therefore unlikely to pond on or run off the surface.
  - However, water may move below the root zone quickly, leaching nutrients and posing a hazard to groundwater quality.
  - Irrigate when required and only long enough to fill the root zone.
- Medium to fine-textured silt and clay soils are very susceptible to surface sealing, which have very low infiltration rates.
  - Water drops hitting the bare soil surface can compact the soil further causing even lower infiltration rates.
  - Reduce operation time on bare soil (e.g., new seedings).
- Surface sealing may occur when the soil does not dry between irrigation events, meaning the soil does not shrink and form pathways for infiltration
  - A sealed soil surface discourages infiltration and promotes ponding and runoff flow, causing erosion.
  - In the spring and fall, operate sprinkler systems with a longer time between irrigations than during peak water use periods.
  - Manage trickle systems to keep the soil water level within the optimum range, but definitely not saturated.
- Poorly drained soils may experience salt build-up when irrigated (from salt already in the soil or in the water). When the soil water evaporates, salt deposits are left at the soil surface.
  - Over-irrigate and drain to move water through the soil; thus, removing the salt build-up.

Water Conservation FACTSHEET

SOIL WATER STORAGE CAPACITY AND AVAILABLE SOIL MOISTURE

Soil Water Storage Capacity and Available Soil Moisture

Soil Characteristics

Soil Texture

Soil texture describes the size of soil particles, which is related to the relative amounts of sand, silt or clay found in the soil. Soil textures can be determined using the soil texture triangle (Figure 5.2) originated from Natural Resources Conservation Service (NRCS), formerly called Soil

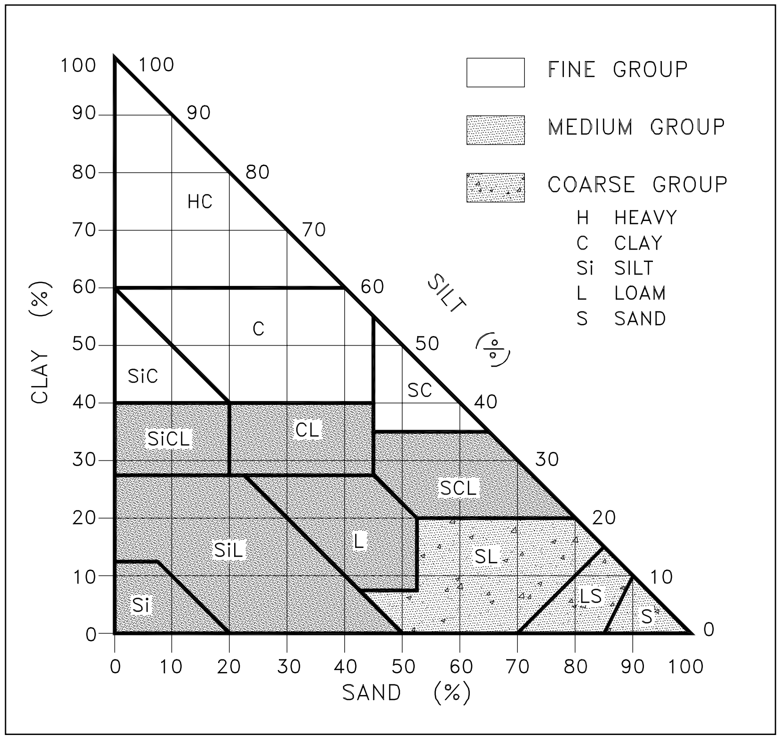
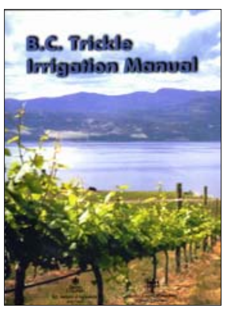


Figure 5.2 Soil Texture Triangle



Conservation Service (SCS). General soil texture classes are described in Table 5.3.

The soil texture has a large influence on the amount of water that can be stored in a soil and on the infiltration rate (the rate that water can infiltrate through the soil). Table 5.3 lists most soil textural groups. Refer to Table 3.10 of the B.C. Trickle Irrigation Manual for a detailed list and the characteristics of each soil type.

B.C. Trickle Irrigation Manual, Table 3.10

➔ **Determination of Soil Texture, Section 5.2**

Table 5.3 Soil Textural Classes

General Texture	Textural Group	Textural Type
sandy	coarse moderately coarse	gravel sand loamy sand sandy loam fine sandy
loamy	medium	very fine sandy loam loam silty loam Silt
clayey	moderately fine fine very fine	sandy clay loam clay loam

Soil Structure

Soil structure is the arrangement of soil particles and soil aggregates into recognizable particles or lumps. Aggregates occur in almost all soils, but their strengths, sizes and shapes vary between soil types. Soil structure can be affected by chemical and physical factors.

Soil Layering

Soil layers may occur naturally due to the way the soils were deposited or may result from chemical cementing within the soil layers caused by tillage induced compaction or land shaping.

A soil layer or the soil depth may reduce the total soil volume available for water storage. A very compact layer or bedrock near the surface limits the depth of root growth and the soil water storage volume.

Infiltration Rate

The infiltration rate determines how fast water enters the soil before running off the surface. It is important to consider the infiltration rate when designing an irrigation system. If the system applies water at a rate greater than the soil can absorb the water, overland flow will occur which may cause environmental concerns.

The infiltration rates may be reduced if the soil surface has been compacted by machinery or water. The impact of water droplets on bare soil from precipitation or the operation of sprinkler irrigation systems may also break up the soil structure on the surface and create a sealing effect preventing water infiltration.

Maximum Application Rate (AR)

Infiltration rate is directly related to maximum application rate (AR). To prevent compaction and runoff, the AR of an irrigation system should not exceed the infiltration rate of the soil. Table 5.4 provides maximum application rates for soils. The rates correspond to the infiltration capacity of the soil without creating overland flow.

Table 5.4 Maximum Application Rates for Various Soil Types

Soil Type	Grass/Sod		Cultivated	
	[in/hr]	[mm/hr]	[in/hr]	[mm/hr]
Clay	0.25	6.5	0.10	2.5
Silt Loam	0.35	9.0	0.15	4.0
Clay Loam	0.30	7.5	0.20	5.0
Loam	0.35	9.0	0.20	5.0
Fine Sandy Loam	0.40	10.0	0.25	6.5
Sandy Loam	0.45	11.5	0.25	6.5
Loamy Sand	0.65	16.5	0.35	9.0
Sand	0.75	19.0	0.40	10.0

Soil Sampling

Soil sampling should be done in an area that has typical soils for the field. If there are two distinctly different soils within the field, a soil sample should be taken and a Soil-Crop Report filled out for both areas. The management of the irrigation system may need to change because of the difference in soil type.

Soil Boundaries

Before the locations of the soil test pits are chosen, major soil boundaries within the field should be determined. The soil boundary can be determined by systematically digging a series of pits in a grid pattern at an interval of 300 – 400 ft (100 – 130 m) to a depth of about 30 in (76 cm). If a change in soil texture occurs between the two pits, the point of change should be marked on the map. Continue in this manner until enough points are known to mark the boundary on the map with reasonable accuracy.

➔ **Determination of Soil Texture, Section 5.2**

Selection of Soil Pit and Soil Sampling

Each major soil type should be sampled in two different places. Select a site where the soil is similar over a large area well away from the soil boundaries. Avoid the top of small ridges and the bottom of small depressions. Make sure the soil sample hole is representative of the area being sampled.

Sampling Interval Depth

The suggested sampling interval depth is 6 in (15 cm). However, if the soil is homogeneous (the same soil type between layers), fewer samples are needed below the 12-in (30-cm) mark. If a major change in soil texture occurs, indicate on the sampling bags the interval at which the texture changes. Figure 5.3 and Table 5.5 provide an example of sampling intervals for a soil where a texture change occurs at a depth of 50 cm. Since the soil is fairly homogeneous, fewer samples are required.

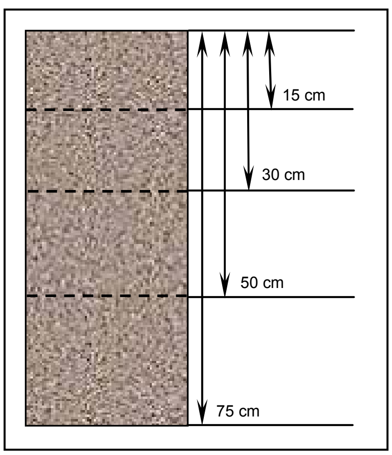


Figure 5.3 Sample Intervals

Table 5.5 Sampling Intervals

Suggested Interval		Modified Interval in Example
[cm]	[in]	[cm]
0 – 15	0 – 6	0 – 15
15 – 30	6 – 12	15 – 30
30 – 45	12 – 24	30 – 50
45 – 60	24 – 36	50 – 75
60 – 75	36 – 48	

Assessment 5.1 Soil Sampling

Follow the steps below to obtain soil samples for irrigation system design and/or management:

Note: All sampling tools must be washed with soap and water, rinsed thoroughly with distilled water and dried with a clean cloth.

1. Determine the soil boundaries.
2. Add the soil boundaries to the base map.
3. For each major soil type, select two soil pit sites. Mark and name the location of each site on the base map (e.g., Pit A and Pit B).
4. Dig the soil pit 3–4 ft (1.0–1.2 m) deep.
5. At 6 in (15 cm) below ground level, force a shovel about 1 in (3 cm) into the side of the pit to remove the surface soil.
6. With a knife, scrape approximately two handfuls of soil from the 1-in (3-cm) hole which was just made in the pit onto the shovel, ensuring a representative sample from the surface to a depth of 6 in (15 cm).
7. Deposit sample into a brand new 1-L plastic freezer bag, and label it as below:

Technician: W. Smith
Location: Pit A
Depth: 0” – 6”

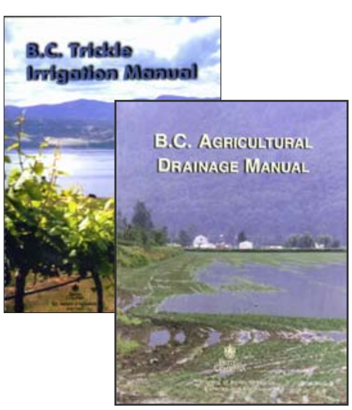
8. Follow the same procedures to obtain soil samples at appropriate intervals.
9. Make a note of the rooting depth of the crop if a root system exists in the ground.
10. Use one of the procedures outlines in the Section 5.2 on Soil Texture to determine the soil type at each interval.
11. Fill out a Soil-Crop Report.

➔ **Soil-Crop Report, Section 5.4**

Determination of Soil Texture

In order to adequately determine soil boundaries, it is necessary to recognize different soil textures in the field. To do this properly, a certain amount of practice is required. Three methods to determine soil texture are described in this section.

Hand-Feel Method



Soil rarely consists of pure sand, silt, clay or gravel, but rather a combination of these components.

➔ **Table 5.3**

The hand-feel method can take years of practice. By using the flow chart (Figure 5.4), it is possible to determine the soil texture.

This method is described in a number of publications, each of which may have a slight variation on the technique. Some techniques may be easier than others for some people. Refer to the following publications:

📖 **B.C. Agricultural Drainage Manual**
📖 **B.C. Trickle Irrigation Manual**

Assessment 5.2 Hand-Feel Method

1. Take a handful of soil.
2. Add small amounts of water while kneading the soil until clods are broken down and the soil becomes pasty.
3. Determine texture by rubbing soil paste between index finger and thumb, and by following the steps in Figure 5.4.

Jar Test

This is a quick test for determining soil texture. The only tools required are a shovel or auger to take soil samples, a standard quart Mason jar and water.

The soil particles once in suspension will settle at the bottom of the jar at different times depending on the size of the particle (Table 5.6). By knowing the depth of each layer and the total depth of the soil sample, it is easy to calculate the percentage of clay, sand and silt in the soil.

There should be differences in colour and size between the sand and silt layers; otherwise, measure the depth of the sand after a minute and subtract the sand depth from the total depth to determine the silt depth. The clay may take days to settle. Wait until the water is mostly clear. Determine its depth in the same way as for the silt. Some of the smallest clay particles may remain permanently in suspension and will not settle out.

Table 5.6 Settling Time for Particles

Soil Type	Settling Time
sand	1 minute
silt	4 – 5 hours
clay	several days

Assessment 5.3 Jar Test

1. Take a cup of soil that is representative of the soil in the root zone.
2. Place the soil in a straight sided mason jar.
3. Fill jar 2/3 full of water.
4. Add 1 teaspoon of a dispersing agent, such as Calgon or table salt.
5. Shake the jar vigorously to break up the soil aggregates and separate the soil particles.
6. Place the jar on a level surface, and let the soil particles to settle.
7. Use a ruler to measure the depth of the various layers.
8. Determine the percentage of each particle size (Example 5.1).
9. Use the soil textural triangle (Figure 5.2) to determine the soil type (Example 5.2).

Example 5.1 Jar Test

Question: A soil column is 6 cm deep with the first 2 cm being sand, the next 2.5 cm silt, and the last 1.5 cm clay. What is the percentage of each soil type?

Calculation and Answer:

$$\textbf{\% Soil Type} = \frac{\textbf{Depth of Soil Type}}{\textbf{Total Depth}}$$

$$\text{\% Sand} = \frac{2\text{ cm}}{6\text{ cm}} = \underline{\underline{33\%}}$$

$$\text{\% Silt} = \frac{2.5\text{ cm}}{6\text{ cm}} = \underline{\underline{42\%}}$$

$$\text{\% Clay} = \frac{1.5\text{ cm}}{6\text{ cm}} = \underline{\underline{25\%}}$$

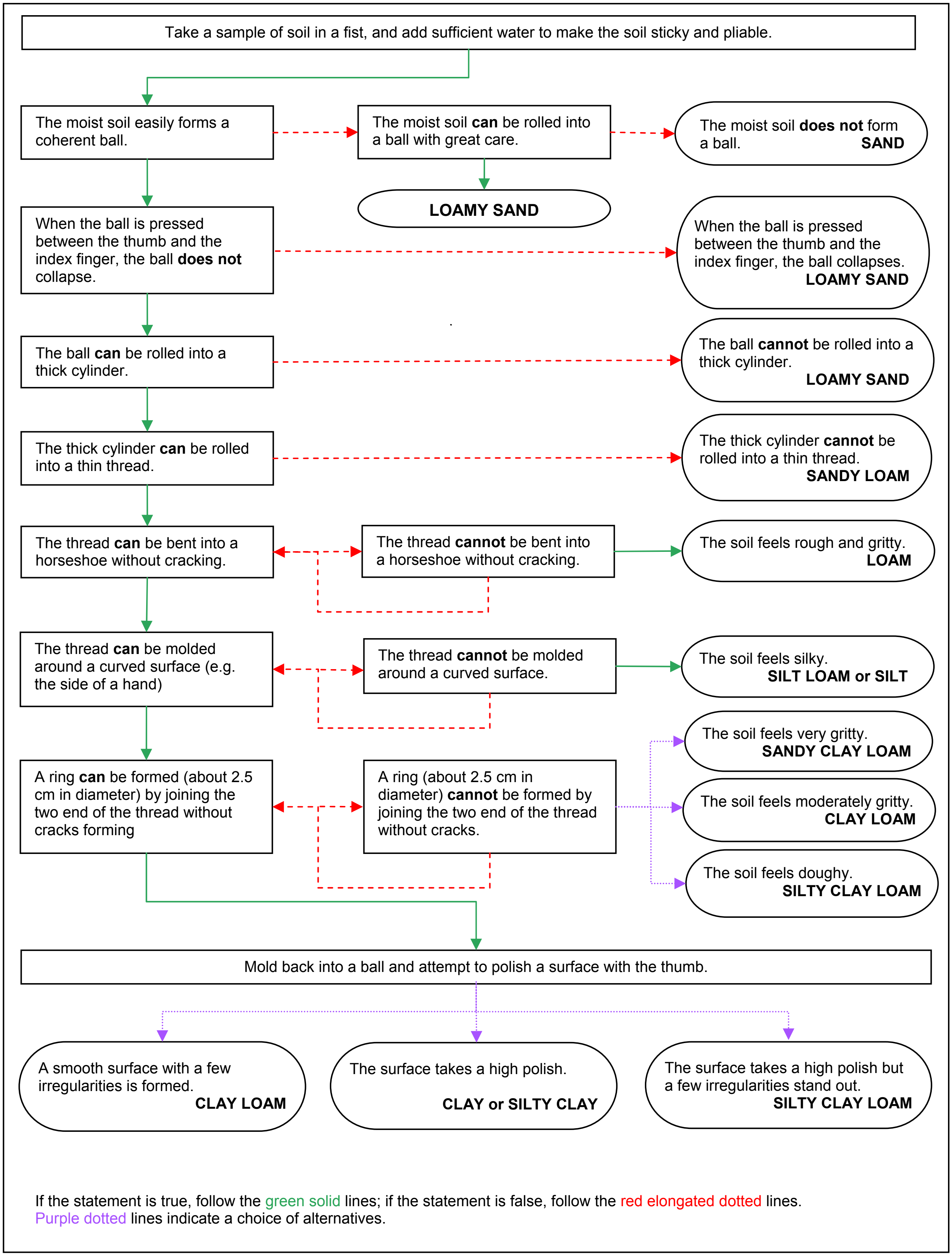


Figure 5.4 Soil Texturing Flow Chart

Laboratory Test

A standard sieve test done in a soil laboratory can be used to determine the proportion of soil sizes in a soil sample as indicated in Table 5.7.

Table 5.7 Soil Particles Sizes

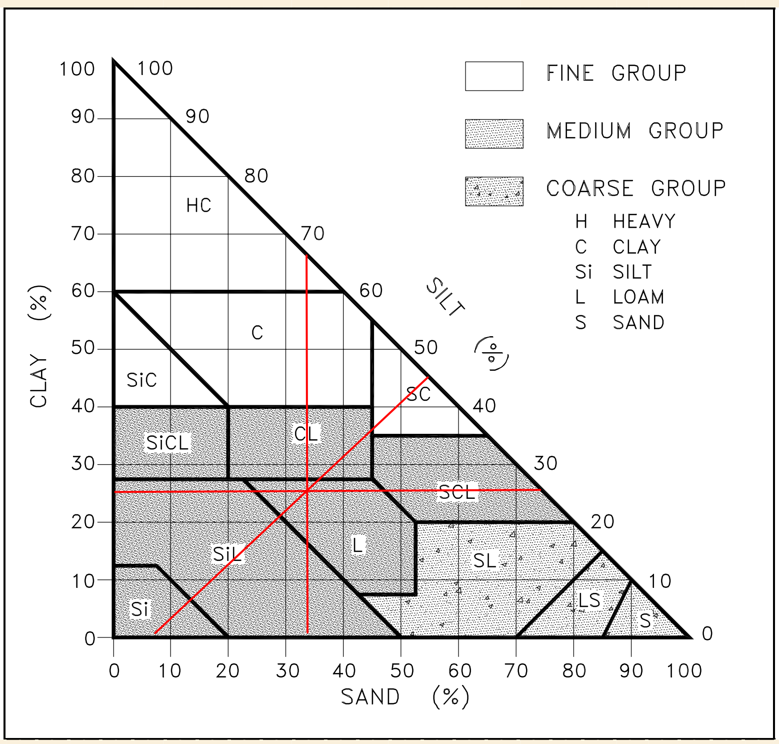
Soil Type	Particle Size [mm]
gravel	2 – 7.5
sand	0.05 – 2.0
silt	0.002 – 0.05
clay	< 0.002

Once the percentage of sand, silt and clay has been determined, use the SCS soil texture triangle to determine the soil texture. Follow the percentage of each soil type from the triangle walls. The location that all lines meet is the soil texture of the sample. Example 5.2 shows how the SCS soil texture triangle identifies major soil textures.

Example 5.2 Using the SCS Soil Textural Triangle to Determine Soil Texture

Question: The soil column consists of 34% of sand, 45% of silt and 25% of clay which are determined in the previous example. What is the soil texture?

Calculation:



Answer: It is a loam soil.

5.3 Soil Water

Parameters for Soil Water

Available Water Storage Capacity (AWSC)

Available water storage capacity (AWSC) of a soil is dependent on the soil texture, soil structure, and the crop's rooting depth. AWSC is the difference between the amount of water in the soil at field capacity and that at the permanent wilting point (Figure 5.5). Finer soils have higher AWSC than coarse soils (Table 5.8). A deeper rooting depth means a larger volume of water is stored in the soil; therefore, a larger reservoir of water for the crop to draw upon between irrigations. To understand water use and water availability to plants, some common soil water terms are defined below.

Saturation

Saturation occurs when all the voids in the soil are completely filled with water. Although plenty of water is available to the crop at saturation, water uptake is seriously curtailed by the lack of oxygen in the soil at soil water contents greater than the field capacity.

Field Capacity

The water content of the soil where all free water has been drained from the soil through gravity. Sandy soils may drain within a few hours but fine textured soils (e.g., clay) may take a few days to drain. Proper irrigation brings soil moisture up to field capacity.

Permanent Wilting Point (PWP)

Permanent wilting point (PWP) is the soil moisture content below which the plant wilts and dies. While there may be water in the soil, the plant is unable to extract sufficient water from the soil to meet its needs.

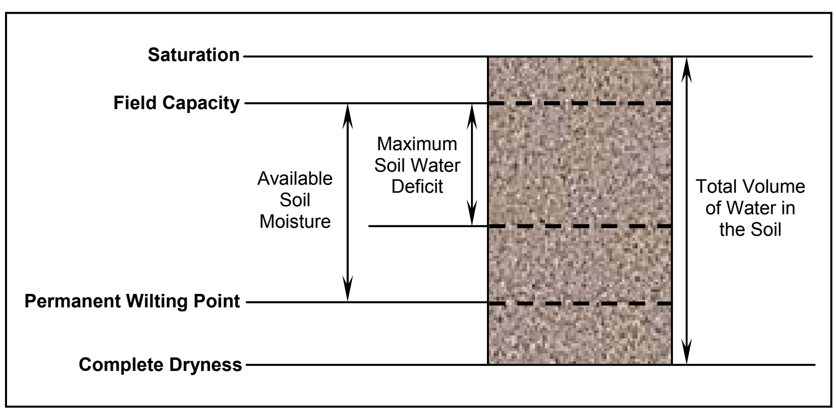


Figure 5.5 Soil Water Moisture Terminology

Table 5.8 Available Water Storage Capacity of Soils		
Textural Class	Available Water Storage Capacity	
	[inches of water per foot of soil]	[mm of water per m of soil]
Sand	1.0	83
Loamy sand	1.2	100
Sandy loam	1.5	125
Fine sandy loam	1.7	142
Loam	2.1	175
Silt loam	2.5	208
Clay loam	2.4	200
Clay	2.4	200
Organic soil (muck)	3.0	250

Soil Water Storage

The amount of water held in the soil and how it moves through the soil depend on the soil texture and structure. The finer soil generally holds more water than a coarser soil. The soil pores in the structure of the soil form a network of connective cavities that can hold water.

For irrigation, the soil water storage (SWS) capacity is defined as the total amount of water that is stored in the soil within the plant's root zone.

Equation 5.1 Soil Water Storage (SWS) ***Worksheets 10(a) and 10(b)***

$$SWS = RD \times AWSC$$

where
SWS = soil water storage [mm]
RD = rooting depth [mm] (Table 5.1 or measured)
AWSC = available water storage capacity [mm of water per m of soil]

Knowing the soil water storage capacity allows the irrigator to determine how much water to apply at each irrigation and how long to wait before the next irrigation. For example, the amount of water applied at one irrigation on a sandy soil with a low soil water storage capacity would be less than that on a loam soil with a higher soil water storage capacity, assuming the crop's rooting depth is the same for both soil types. Applying water to the soil at an amount more than the soil water storage capacity results in water loss to deep percolation and leaching of nutrients beyond the root zone.

Maximum Soil Water Deficit (MSWD)

The maximum soil water deficit (MSWD) is the amount of water stored in the soil that is readily available to the plant. Only a portion of the total soil water is readily available for plant use. Plants can only extract a portion of the stored water without being stressed. An availability coefficient (AC) is used to calculate the percentage of water that is readily available to the plant (Table 5.2). To prevent plant water stress, an allowable depletion factor is used to calculate the manageable allowable depletion. This factor varies but is usually around 50%. The crop should be irrigated once about 50% of the moisture has been removed from the soil. It is also the maximum amount that can be applied at one time before the risk of deep percolation occurs. However, in some cases, leaching of salts is desirable and extra irrigation would be required.

Equation 5.2 Maximum Soil Water Deficit (MSWD) *Worksheets 10(a) and 10(b)*

$$MSWD = SWS \times AC$$

where MSWD = maximum soil water deficit [mm]
SWS = soil water storage [mm]
AC = availability coefficient [% expressed as a decimal]

The Agricultural Research Service and the Department of Biological Systems Engineering at the Washington State University developed a **hydraulic properties calculator** for determining soil water characteristics. This calculator estimates soil water tension, conductivity and water holding capability based on the soil texture, organic matter, gravel content and salinity and can be found at the website below.

www.bsyse.wsu.edu/saxton/soilwater

5.4 Soil-Crop Report

When making management decisions, some specific information about the soil and the crop growing in the soil is important to know, and can be obtained from the farm site. The soil pits should be located in areas that represent the soil conditions of the field.

If the soil-crop report shows that very different soil types are present within a field, managing the irrigation system for all soil types might be very difficult. In this case, the field should be divided into management zones with a different irrigation management plan for each zone.

Assessment 5.4 Soil-Crop Report

Worksheet 10

Information

- Record crop type.
- Record crop's rooting depth, i.e., where the root zone ends. Determine the root zone depth while digging a soil pit.
- Record soil texture from a depth within the root zone.

  ➔ **Determination of Soil Texture, Section 5.2**
- Record the maximum application rate (AR) for the soil (Table 5.4).
- Determine the available water storage capacity (AWSC) (Table 5.8).

Step 1. Determine soil water storage (SWS)

- Calculate only the depth within the root zone (Equation 5.1).

Step 2. Determine maximum soil water deficit (MSWD)

- Calculate MSWD for each pit (Equation 5.2).
- Calculate average MSWD for the field.

Refer to Figures 4.1 and 4.2 for soil pit locations. In addition, the following items can be added to the farm plans:

- Soil boundaries
- Locations of soil pits
- Areas that show:
  - Stoniness (scattered, medium or very stony)
  - Poor drainage (seepage areas)
  - Gravel ridges
  - Depth to water table (if present)

Example 5.3(a) Sprinkler Irrigation System in Armstrong (V)
Worksheet 10(a) Soil-Crop Report

Question: Continuation of the sprinkler irrigation system example in Armstrong (Chapter 4). The crop grown is alfalfa in a sandy loam soil.

Information:

Pit	A		B		C	
Crop	*alfalfa*		*alfalfa*		*alfalfa*	
Rooting Depth (RD) [m]	*1.2*		*1.2*		*1.2*	
Availability Coefficient (AC) [decimal], Table 5.2	*0.50*	1	*0.50*	1	*0.50*	1
Maximum Application Rate (AR) [mm/hr], Table 5.4	*11.5*		*11.5*		*11.5*	

Soil Depth [m]	RD* [m]		Texture	AWSC [mm/m]		SWS [mm]		Texture	AWSC [mm/m]		SWS [mm]		Texture	AWSC [mm/m]		SWS [mm]	
0.0 – 0.3	*0.3*	2	*SL***	*125*	3	*37.5*	4	*SL*	*125*	3	*37.5*	4	*SL*	*125*	3	*37.5*	4
0.3 – 0.6	*0.3*	2	*Fine SL*	*142*	3	*42.6*	4	*SL*	*125*	3	*37.5*	4	*Fine SL*	*142*	3	*42.6*	4
0.6 – 0.9	*0.3*	2	*SL*	*125*	3	*37.5*	4	*SL*	*125*	3	*37.5*	4	*SL*	*125*	3	*37.5*	4
0.9 – 1.2	*0.3*	2	*SL*	*125*	3	*37.5*	4	*LS****	*100*	3	*30*	4	*LS*	*200*	3	*30*	4
Total SWS [mm]						*155*	5				*142.5*	5				*147.5*	5
MSWD [mm]						*77.5*	6				*71*	6				*74*	6
Sum of MSWD [mm]																*222.5*	7

* RD = soil depth is only calculated for the soil in the root zone. ** SL = sandy loam ***LS = loamy sand

Sample Calculations – Pit A:

Step 1. Calculate soil water storage (SWS)

(a) Calculate SWS for each soil depth interval that has roots. Use the first interval as an example.

Equation 5.1

SWS = RD x AWSC

= *0.3* [2] m x *125* [3]

= *37.5* [4] mm

(b) Total SWS within the zone

Total SWS = SWS$_{(0-0.3\ m)}$ + SWS$_{(0.3-0.6m)}$ + SWS$_{(0.6-0.9\ m)}$ + SWS$_{(0.9-1.2\ m)}$

= (*37.5* [4] + *42.6* [4] + *37.5* [4] + *37.5* [4]) mm

= *155* [5] mm

Step 2. Calculate MSWD

(a) **Equation 5.2**

MSWD = SWS x AC

= *155* [5] mm x *0.50* [1]

= *77.5* [6] mm

(b) Calculate average MSWD for all soil pits

Average MSWD = Sum of MSWD / Number of Readings

= *222.5* [7] mm / *3*

= *74* [8] mm

Note: *If the soil types and values vary a lot between soil pits, e.g., sandy loam in one area and clay loam in another area, the area within the soil boundaries should be managed separately. Do not average these values. Rather, keep a separate record of each soil area.*

Example 5.3(b) Trickle Irrigation System in Kelowna (III)
Worksheet 10(b) Soil-Crop Report

Question: Continuation of the trickle irrigation system example in Kelowna (Chapter 4). The crop grown is high-density apples and grapes in a (mainly) sandy loam soil.

Information:

Pit	A	B	C
Crop	*apples*	*grapes*	–
Rooting Depth (RD) [m]	*0.7*	*1.0*	–
Availability Coefficient (AC) [decimal], Table 5.2	*0.40* **1**	*0.40* **1**	– **1**
Maximum Application Rate (AR) [mm/hr], Table 5.4	*6.5*	*6.5*	–

Soil Depth [m]	RD* [m]	Texture	AWSC [mm/m]	SWS [mm]	Texture	AWSC [mm/m]	SWS [mm]	Texture	AWSC [mm/m]	SWS [mm]
0.0 – 0.3	*0.3* **2**	*SL***	*125* **3**	*37.5* **4**	*SL*	*125* **3**	*37.5* **4**	–	– **3**	– **4**
0.3 – 0.7	*0.4* **2**	*SL*	*125* **3**	*50.0* **4**	*SL*	*125* **3**	*50.0* **4**	–	– **3**	– **4**
0.7 – 1.0	*0.3* **2**	*SL*	*125* **3**	*–** **4**	*SL*	*125* **3**	*37.5* **4**	–	– **3**	– **4**
Total SWS [mm]				*87.5* **5**			*125* **5**			– **5**
MSWD [mm]				*35* **6**			*50* **6**			– **6**
Sum of MSWD [mm]										*85* **7**

* RD = soil depth is only calculated for the soil in the root zone. ** SL = sandy loam
* Roots only go up to 0.7 m.

Sample Calculations – Pit A:

Step 1. Calculate soil water storage (SWS)

(a) Calculate SWS for each soil depth interval that has roots. Use the first interval as an example.

Equation 5.1

SWS = RD x AWSC

= *0.3* **2** m x *125* **3**

= *37.5* **4** mm

(b) Total SWS within the zone

Total SWS = $\mathbf{SWS_{(0-0.3\,m)} + SWS_{(0.3-0.7m)} + SWS_{(0.7-1.0m)}}$

= (*37.5* **4** + *50.0* **4** + *–* **4**) mm

= *87.5* **5** mm

Step 2. Calculate MSWD

(a) **Equation 5.2**

MSWD = SWS x AC

= *87.5* **5** mm x *0.40* **1**

= *35* **6** mm

(b) Calculate average MSWD for all soil pits

$$\textbf{Average MSWD} = \frac{\textbf{Sum of MSWD}}{\textbf{Number of Readings}}$$

= *85* **7** mm / *2*

= *42.5* **8** mm

Note: *If the soil types and values vary a lot between soil pits, e.g., sandy loam in one area and clay loam in another area, the area within the soil boundaries should be managed separately. Do not average these values. Rather, keep a separate record of each soil area.*